

ELECTRONIC FUNDAMENTALS

SERVICE PRACTICES 10

HOW TO TEST TUBES

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Service Practices 10

INTRODUCTION

A majority of the troubles in radio and television receivers are due to electron-tube failure. Electron tubes are liable to fail more often than any other parts in the receiver because they operate at very high temperatures and they are constructed of very delicate and fragile parts that are very closely spaced in the metal or glass container, or *envelope* of the tube. In this lesson, you will learn two methods of testing tubes and something about the construction and theory of operation of electron tubes.

10-1. ELECTRON-TUBE CONSTRUCTION

Most electron tubes consist of four major parts, or *elements*, as they are called. Figures 10-1 and 10-2 show two ways in which these elements may be arranged. The major parts or elements are:

1. A *filament* or *heater*, which is a loop or coil of fine wire or ribbon, somewhat similar to the filament in an electric-light bulb. When current flows through it, the filament becomes heated. The heat causes electrons to be given off or *emitted* from the surface of the filament. The process by which metals *give off* electrons when heated is called *electron emission*. In some tubes, the electrons are emitted directly from the filament. The construction of a typical tube of this type is shown in Fig. 10-1. In most tubes, however, the supply of electrons is obtained from a cathode.

2. The *cathode*, which is a metallic sleeve that surrounds the filament, and is heated by it. It is chemically coated with substances that, when they are heated, readily emit electrons. The construction of a typical tube using a cathode is shown in Fig. 10-2.

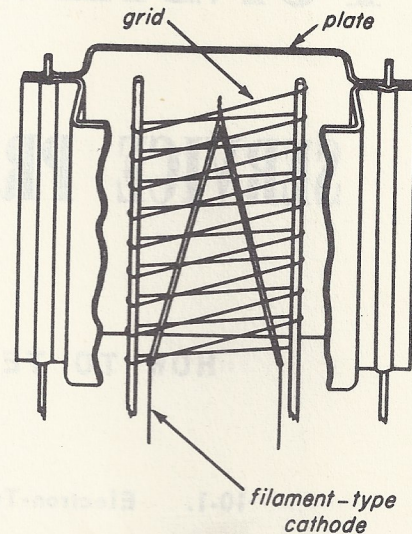


Fig. 10-1

3. The *grid*, which is a fine wire screen whose purpose is to control the flow of electrons in the tube. In most receiving tubes, the grid is constructed of wire that is finer than human hair, and it is placed very close to the other tube elements. Most tubes have one or more grids, but some tubes,

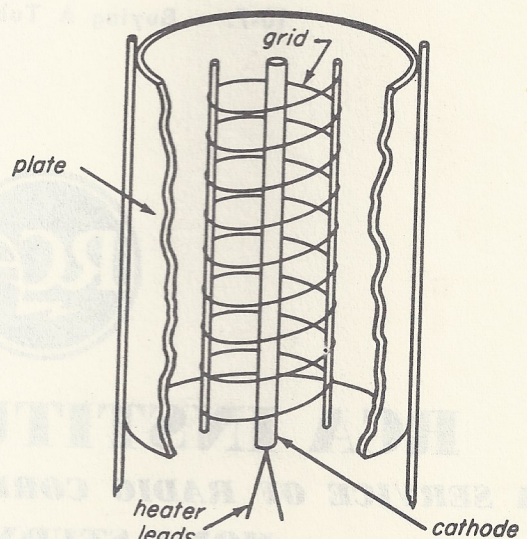


Fig. 10-2

such as diodes or rectifier tubes, do not have any grids at all.

4. The *plate*, or *anode*, which is a metal structure, either in the shape of a cylinder, as in Fig. 10-1, or in the shape of a rectangle, as in Fig. 10-2. Its purpose is to receive or collect the electrons that have been emitted from the filament or cathode of the tube.

Many tubes are multi-purpose tubes; that is, they may have several grids, plates, or other elements in one envelope.

10-2. ELECTRON-TUBE DEFECTS

By looking at Fig. 10-3, which shows the construction of a modern miniature glass receiving tube, you will get some idea of the complicated and delicate structure of modern electronic tubes. Such tubes operate at temperatures of several hundred degrees. The tube elements are very fragile and very closely spaced. It should not be surprising therefore, that a great many defects may develop in electron tubes. These defects may cause the tubes either to stop operating,

have reduced or insufficient output, become *intermittent* in their operation, or introduce distortion into the output signal.

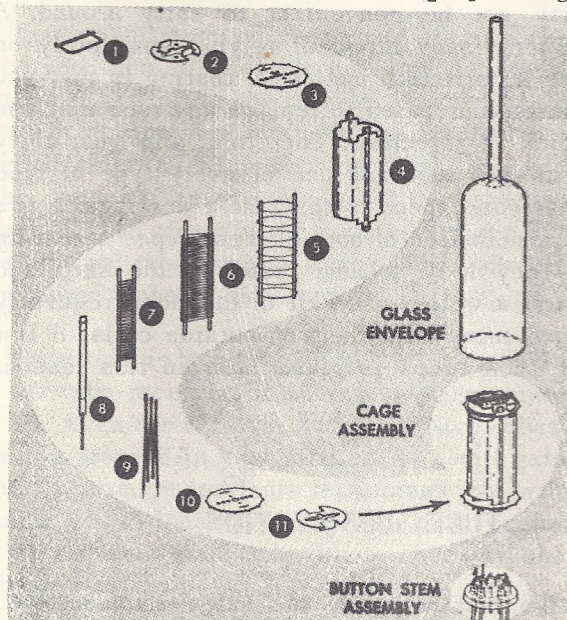
These defects are as follows:

1. *Open filament*. The filament wire may open due to age, mechanical shock, or poor connections so that there is no longer a complete circuit for current flow through the filament. The filament cannot become heated, and a supply of electrons for the operation of the tube is not introduced. If the tube is in a series-filament circuit, or *series string* as it is called, the open filament will prevent current flow in each of the tubes.

Occasionally, the filament breaks, but in such a way that the two ends of the filament at the break touch while the filament is cold, thus allowing current to flow through it. However, as soon as the filament is heated by the current flow, it expands, and the two ends at the break separate. The circuit is opened, and the current stops. After a while, the filament cools, the ends touch again, and the cycle starts over again. Thus, the filament blinks on and off.

2. *Low emission*. This condition occurs when the filament or cathode can no longer supply the amount of electrons necessary for the operation of the tube. When the emission of the tube begins to fall off, the output of the tube is reduced, until finally the tube must be replaced.

3. *Inter-element shorts*. Due to loose connections, rough mechanical handling, or loose particles inside the tube, an unwanted connection may occur between the various elements of the tube. If the unwanted connection between the elements has a low resistance, it is called a *short*, or *direct short*. If the unwanted connection between the elements has a high resistance, we say that there is *leakage*, or *high-resistance short*, between the elements. Such shorts interfere with the operation of the tube and usually make it necessary for the tube to be discarded. In amplifier tubes using a heater and



CAGE PARTS

- | | | |
|-----------------------|---------------------------------|--------------------------|
| 1. Getter and Support | 5. Grid No. 3
(Suppressor) | 8. Cathode |
| 2. Top Spacer Shield | 6. Grid No. 2 (Screen) | 9. Heater |
| 3. Insulating Spacer | 7. Grid No. 1
(Control Grid) | 10. Insulating Spacer |
| 4. Plate | | 11. Bottom Spacer Shield |

Fig. 10-3 The Parts of a Miniature Pentode

cathode, leakage between these two elements may cause the 60-cycle a-c heater voltage to leak to the cathode and cause hum in the output of the receiver. Sometimes a short occurs only after the tube has been in operation for several hours, or only if the tube is tapped, or a combination of these conditions. Methods for finding all of the various kinds of shorts will be described later in this booklet.

4. *Microphonics*. This term is used to describe a tube in which the elements are loose enough to shake or vibrate and cause undesirable noises in the output.

5. *Gassy tubes*. Most electron tubes in radio receivers have a very high vacuum inside the tube envelope; that is, as much of the air as is practicable is removed from the tube envelope before it is sealed. A very small amount of air in the tube will interfere with the proper operation of the tube. A tube with air in it is called gassy.

If more than a very small amount of air enters the tube, the filament will burn out almost immediately, making the tube useless. This condition can be recognized by the milky-white coating that can be seen on the inside of glass tubes.

6. *Open element connections*. Connections to tube elements are made by wire leads. The connection between the lead and the element is usually made by a spot weld. Due either to mechanical shock or repeated expansion and contraction, these connections may open. The connection either may remain open permanently or it may be open only while the tube is hot. Sometimes, due to improper tube operation or defective circuit components, too much current may flow in one of these leads and burn it out, opening the connection to one of the elements. This happens most frequently in *rectifier* tubes, in which a short circuit in the receiver burns out the connection at the cathode, called the *cathode tab*.

7. *Open Elements*. The elements of an electron tube are connected to tube pins in

the base of the tube by wire leads. These leads are soldered into the base pins. Sometimes these solder connections may open up and cause either *intermittent* operation or failure of the tube.

10-3. METHODS OF TUBE TESTING

There are two general methods of testing tubes. One is the *substitution* method, where a tube of the proper type that is known to be good is substituted for a suspected tube in a receiver. If the trouble disappears when the test tube is in the socket, the suspected tube probably is defective. You will learn about one or two cases in which this is not true later in this lesson.

The other method of testing tubes is the *tube tester* method. Tubes are tested by specially designed testing instruments called *tube-testers* or *tube checkers*.

There are some advantages and disadvantages to both methods. The greatest advantage of the substitution method is that a tube tester is not needed. Tube testers are expensive and may not be convenient to carry around. A major disadvantage of relying completely on the substitution method of testing is that you must be prepared to replace any tube that you think is defective. Therefore, you must carry with you at least one of every type of tube that you expect to test. Most servicemen use a combination of both of these types of testing—they have a tube tester in the shop and carry a well-chosen kit of the most frequently used tubes with them on outside calls. A list of such tubes is given later in this lesson.

10-4. TUBE SUBSTITUTION

To test tubes by the substitution method, you replace the suspected tube in a receiver with a good tube of the same type number. After allowing sufficient warm-up time, you see whether the trouble has been removed and the receiver operates normally. If it does, then

the tube that the test tube has replaced is defective. If it does not, replace the original tube, and substitute a good tube for each of the other of the tubes in the receiver until either a defective tube is found, or all of the tubes check good. Turn the receiver power switch off each time before changing tubes. Substitute one tube at a time, and replace the original tube before going on to the next one. This will prevent you from getting tubes back into the wrong sockets. By means of other tests which you will learn later, you will usually be able to *localize* the trouble to a certain section of the receiver so that only a few tubes have to be tested. However, if you cannot localize the trouble to a certain section of the receiver, you will have to test all of the tubes.

Some servicemen like to keep a set of testing tubes especially for this purpose. They label them in some distinctive way so that they can easily be recognized and not left in the customer's receiver. If they locate a defective tube with the test tubes, they remove the test tube and replace the defective tube with a brand new tube from stock. In this way, they do not have to open a new tube carton for a test tube and then put the tube back if that tube is not used.

If there is more than one bad tube in the receiver, then substituting one good tube at a time will not locate the trouble. However, this may not happen very often. If you suspect that the receiver might have more than one bad tube, you can replace all the tubes with good tubes. If this clears up the trouble, then replace the original tubes one at a time while observing to see if the trouble returns.

While this is a practical method for a five-to six-tube receiver, it becomes inconvenient to use when the receiver has many more tubes. As you proceed in your studies, you will gain more knowledge and learn techniques that will enable you to localize the trouble to a section of the receiver without having to check all the tubes.

There are certain precautions to keep in mind when using this method of tube testing:

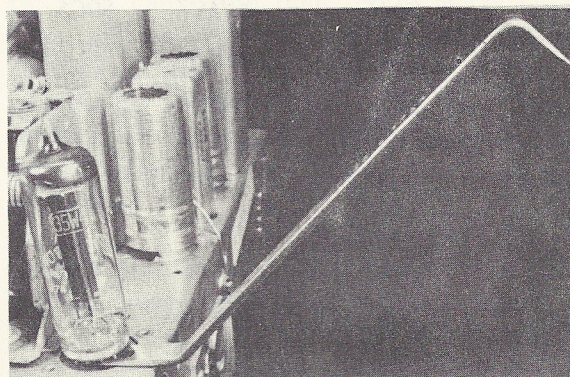
Do not substitute tubes when there is danger of damage to the test tube. If you see the

plates of a tube glowing red, or see any other signs of overheating, it is best to investigate and locate the source of the trouble before substituting new tubes.

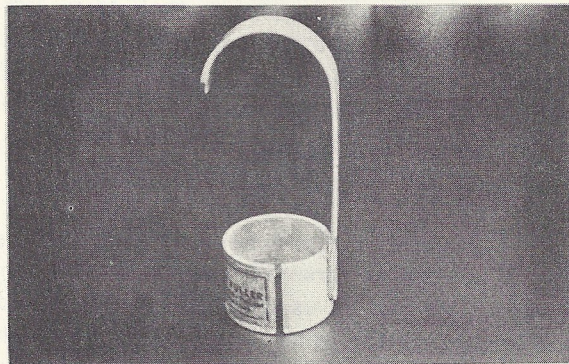
Special precautions must be taken before substituting tubes in a three-way or battery portable. These will be described in the lesson on these receivers.

Since many tubes become hot enough to burn the fingers, a tube puller or lifter is a useful device for removing hot tubes or tubes located in tight places on the chassis where there is not room for fingers. Figure 10-4a shows a lifter for miniature glass tubes, and Fig. 10-4b shows a tube puller for standard-size metal and glass tubes.

In certain circuits, a tube may not operate even though it is a good tube. This is the exception that was mentioned earlier in connection with tube substitution. Such tubes should not be discarded, but saved for use in other circuits. Examples of such circuits will be given in later lessons.



(a)



(b)

Fig. 10-4

10-5. RECOMMENDED TUBE LIST

Relying upon tube substitution alone for testing tubes requires that the serviceman have at least one of every tube type that he is likely to come across. While it is possible to have such a stock of tubes in the shop, it is not practical to take so many tubes on outside calls.

The list in Table A is a guide to the tubes most frequently used in home and portable radio receivers. We asked the head of one of the largest radio and television service organizations in the country just which tubes a man should carry on service calls. He sent us the list in Table A. From this list, you can tell which tubes to carry with you on outside calls. Also, since it represents the most frequently used tubes, it can guide you in ordering stock for your shop.

TABLE A - FREQUENTLY USED TUBES

1R5	6AU6	6X5-GT	35Z5-GT
1T4	6AV6	12AT6	50B5
1U4	6BA6	12AV6	50C5
1U5	6BE6	12BA6	50L6-GT
3S4	6J5	12BE6	
3V4	6K6-GT	12SA7	
5U4-GB	6SA7	12SK7	
5Y3-GT	6SK7	12SQ7	
6AL5	6SQ7	25L6	
6AQ5	6V6	25Z6-GT	
6AT6	6X4	35W4	

Bear in mind, however, that this list refers to tubes used in radio receivers and radio-phono combinations. While some of them are used in television receivers, many other tubes in addition to these must be carried by the television serviceman.

As a general rule, a tube which has the letter G or the letters GT following the tube designation may be used as a replacement for a tube having the same designation but without these letters following it. These letters describe the type of envelope that the tube

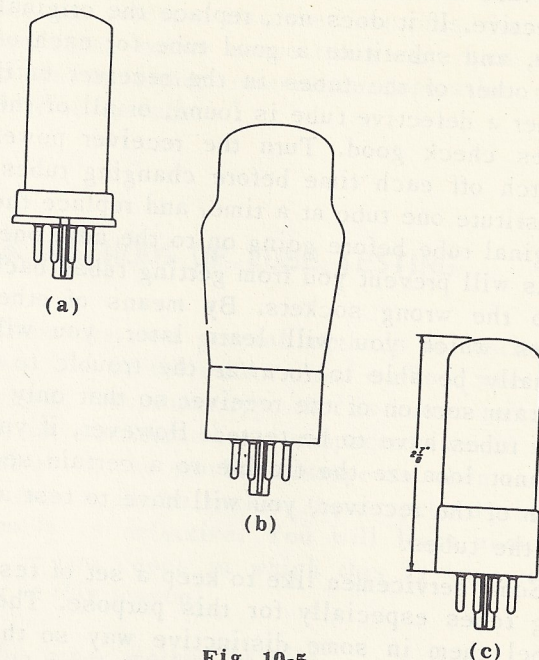


Fig. 10-5

has. For example, tube types 6F6, 6F6-G, and 6F6-GT are all the same electrically, except for minor details. Type 6F6 is in a metal envelope, as shown in Fig. 10-5a, type 6F6-G is in a large glass envelope, as shown in Fig. 10-5b, and type 6F6-GT is in a small, straight-sided glass envelope as shown in Fig. 10-5c. In most home radio receivers, any one of these may be used for a replacement for one of the others.

In substituting one tube for another, such as a glass tube for a metal tube, there is one very important point to remember. Pin 1 of a metal tube is connected to the metal shell of the tube. In a receiver, the socket terminal that connects with pin 1 is grounded to the chassis, and the circuit in which the tube operates is designed to take advantage of the shielding effect that results from these connections. If a glass tube is substituted for a metal tube, there will be no shield or connection to pin 1. Without a shield, the circuit may become unbalanced and cause the circuit to operate improperly. In such cases, only a metal tube will give satisfactory service.

Several tube manufacturers are now producing certain heavy-duty tubes, which are similar to but more rugged than the regular types.

These are designated by an additional letter A, B, or C. An example of this is the regular type 5U4-G rectifier tube, and the types 5U4-GA and 5U4-GB. The GA and GB types may be used to replace a regular type 5U4-G. However, the regular type may overheat excessively when it is used to replace one of the more rugged types, depending upon the circuit it is being used in.

10-6. TUBE TESTERS

Although tube substitution is a very reliable method of testing tubes, there are many reasons why a tube tester is a valuable piece of test equipment for the technician to have. The tube tester can do the following:

1. Test tubes that are not in a receiver, as when a group of tubes are brought in by a customer for testing.
2. Test every receiving tube and many special-purpose and industrial tubes.
3. Enable more accurate comparisons to be made between tubes. A well-designed tube tester can give an estimate of useful life to be expected from a tube, and thus point out those tubes that are going bad.
4. Provide a "Good-Bad" scale or similar scale (sometimes called an *English reading scale*) to show the condition of the tube to non-technical customers.

Types Of Tube Testers. A tube tester is a test instrument that applies certain voltages to all or some of the elements of an electron tube and measures the current flow. The amount of current flowing is used as a measure of the quality or condition of the tube. Most tube testers also check tubes for other defects, such as interelement shorts, leakage, microphonics, and gas. Such defects are shown either by deflection of the tube-tester meter or by neon-lamp indicators.

A typical scale used with tube testers is shown in Fig. 10-6. About half of the scale is labelled BAD or REPLACE, and the other half is labelled GOOD. The good section usually is colored green and the bad section usually is colored red for easy identification. Between these two sections, there is usually a

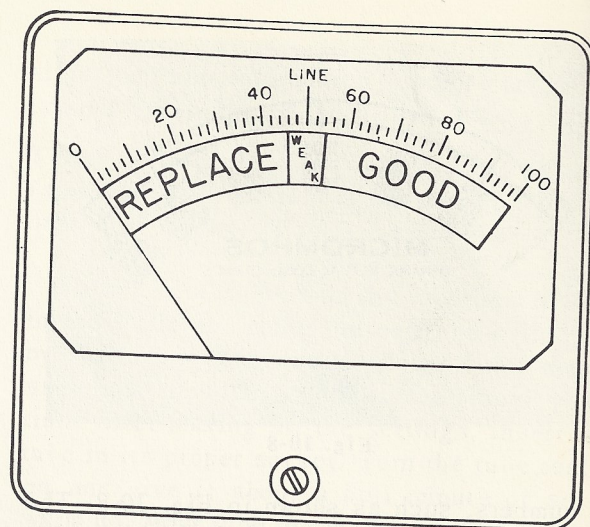


Fig. 10-6

small section labelled with a question mark, or WEAK. A tube tester reading in this section indicates that the condition of the tube is doubtful. Whether or not such a tube should be replaced depends upon the use to which the tube is put and the judgment of the technician. Some testers also have a small red or doubtful section at the extreme right of the meter scale, as shown in Fig. 10-7. The purpose of this section is to call attention to tubes that appear to test extremely good; that is, they cause the tube tester meter to deflect all the way to maximum. A tube that appears to give an abnormally high reading is probably as bad as one which gives a low reading, because such high readings may be due to either gas or shorted elements within the tube.

Some tube testers do not have an English reading (Bad-Good) scale, but are calibrated

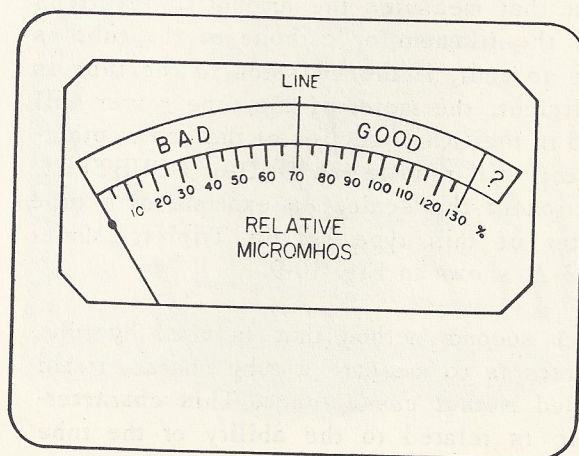


Fig. 10-7

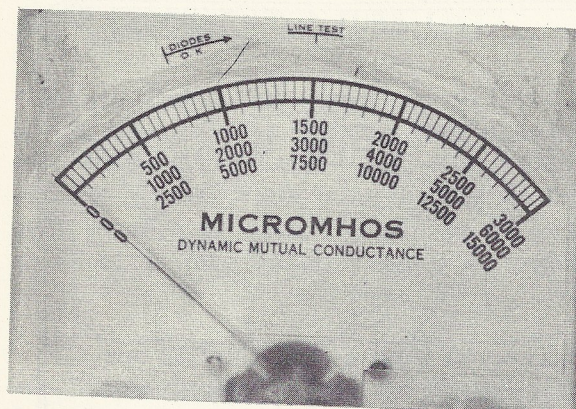


Fig. 10-8

in numbers, such as shown in Fig. 10-8. The readings obtained for a particular tube are compared with the figure given in the tube-tester chart to see whether the tube is good or bad. Many tube testers may have both of these scales, and the serviceman may use whichever is more convenient.

A number of tube testers are also designed to be used as volt-ohm-milliammeters, or similar analyzers, and therefore the meter scale may resemble that of a volt-ohm-milliammeter plus an added tube-tester scale.

There are three general methods by which tube testers determine the condition of a tube. We will briefly describe the three principles involved. You will learn more about them when you study the Theory Lessons on electron tubes and their applications.

The first method is *emission testing*, and tube testers using this method are called *emission testers*. They use a circuit arrangement that measures the amount of electrons that the filament or cathode of the tube is able to emit. If the emission of the tube is sufficient, the meter of the tube tester will read in the GOOD section of the scale; otherwise it will read in the BAD or DOUBTFUL section of the scale. An example of a tube tester of this type is the Triplet Model 3413-A, shown in Fig. 10-9.

A second method that is used by tube testers is to measure a tube characteristic called *mutual conductance*. This characteristic is related to the ability of the tube to amplify signals. Such checkers are

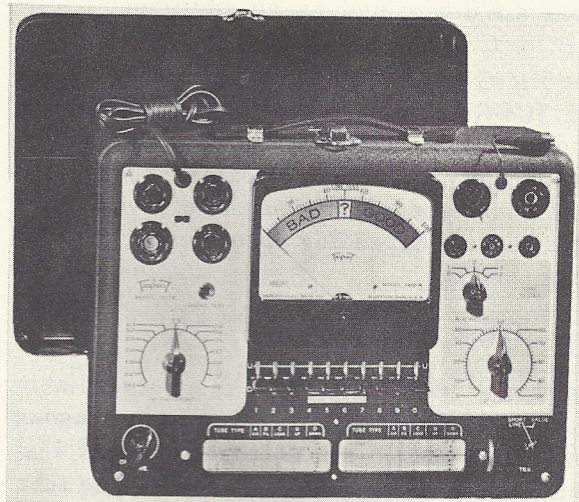


Fig. 10-9

called mutual conductance checkers. A typical tube tester of this type is the Hickok Model 600A shown in Fig. 10-10.

The third method that is used by tube testers is based on a circuit arrangement that measures the power output of the tube with a certain fixed signal applied to the control grid of the tube. A tube tester of this type is the Precision Series 10-12 shown in Fig. 10-11.

Most tube testers use one of the three methods that have been described to judge the condition of the tube. Some testers combine two of these tests to make a more complete composite test for judging the condition of tubes.

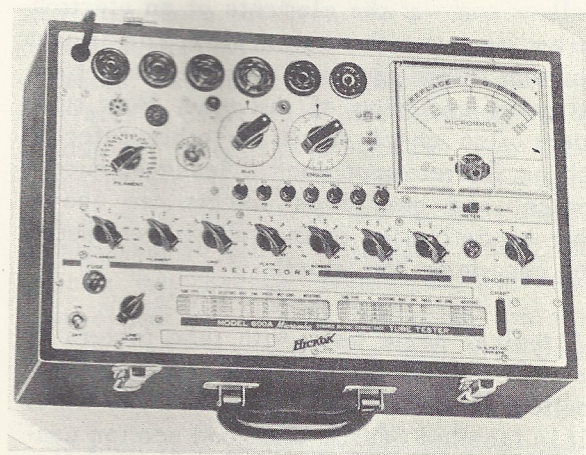


Fig. 10-10

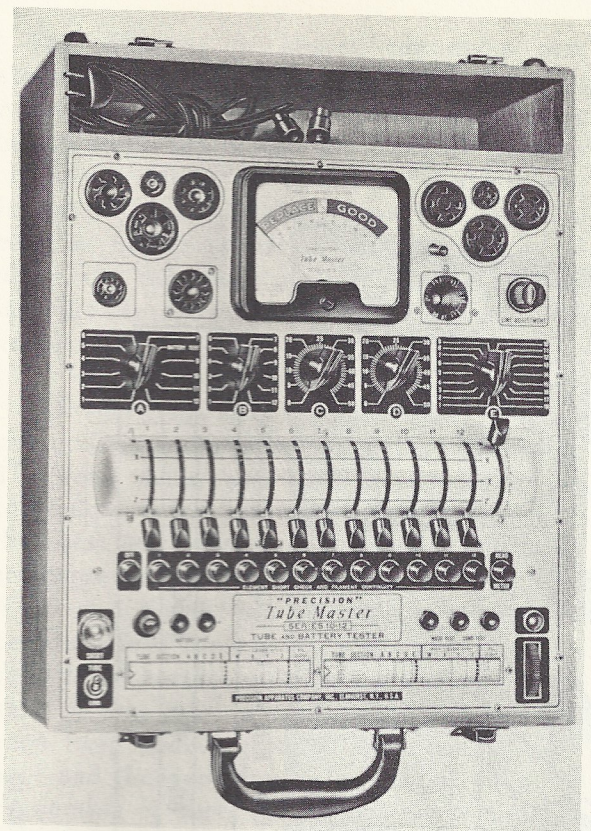


Fig. 10-11

Diodes and rectifier tubes, which do not have grids, are tested by the emission test method on all tube testers.

Using The Tube Tester. The following general information applies to the testing of any tube in any tester. The next section describes how to test a tube on a typical tester, the Hickok Model 605A shown in Fig. 10-12.

Before attempting to check tubes on any tube tester, read the instructions for the particular model that you have. Some testers have enough instructions on the front panel to tell how to use that tube tester. For other testers, it is necessary to read the instruction book for a particular model. Be sure you know how to use the tube tester before you proceed.

To test a tube on the tube tester, it is necessary to make a half-dozen or more settings of switches, dials, or pushbuttons. The information for making these settings is obtained from a roller chart that can be seen on the top of the tube tester. Occasion-

ally, the tube information is contained in booklet that comes with the tube tester.

These settings must be made before any tube is inserted in its socket on the tube tester, otherwise damage to the tube may result.

To test a tube, look up the tube designation in the chart and make the settings called for by the chart. This means setting the dials, switches, or pushbuttons to the proper position. After making all the settings, insert the tube in its proper socket. Turn the tube tester on and give it about a half minute or so to warm up. Most tube testers have a line-voltage adjustment provision to compensate for different supply voltages and the different currents drawn by various tubes. The line-voltage adjustment is made at this point, in accordance with the instructions for the particular tester that you are using.

The tube testing procedure usually consists of several tests and they should be made in this order:

1. Filament or heater continuity check
2. Short tests
3. Quality tests
4. Gas test
5. Noise and microphonics
6. Special tests

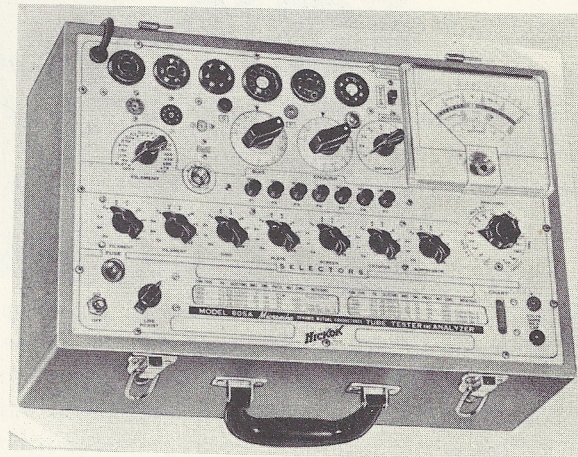


Fig. 10-12

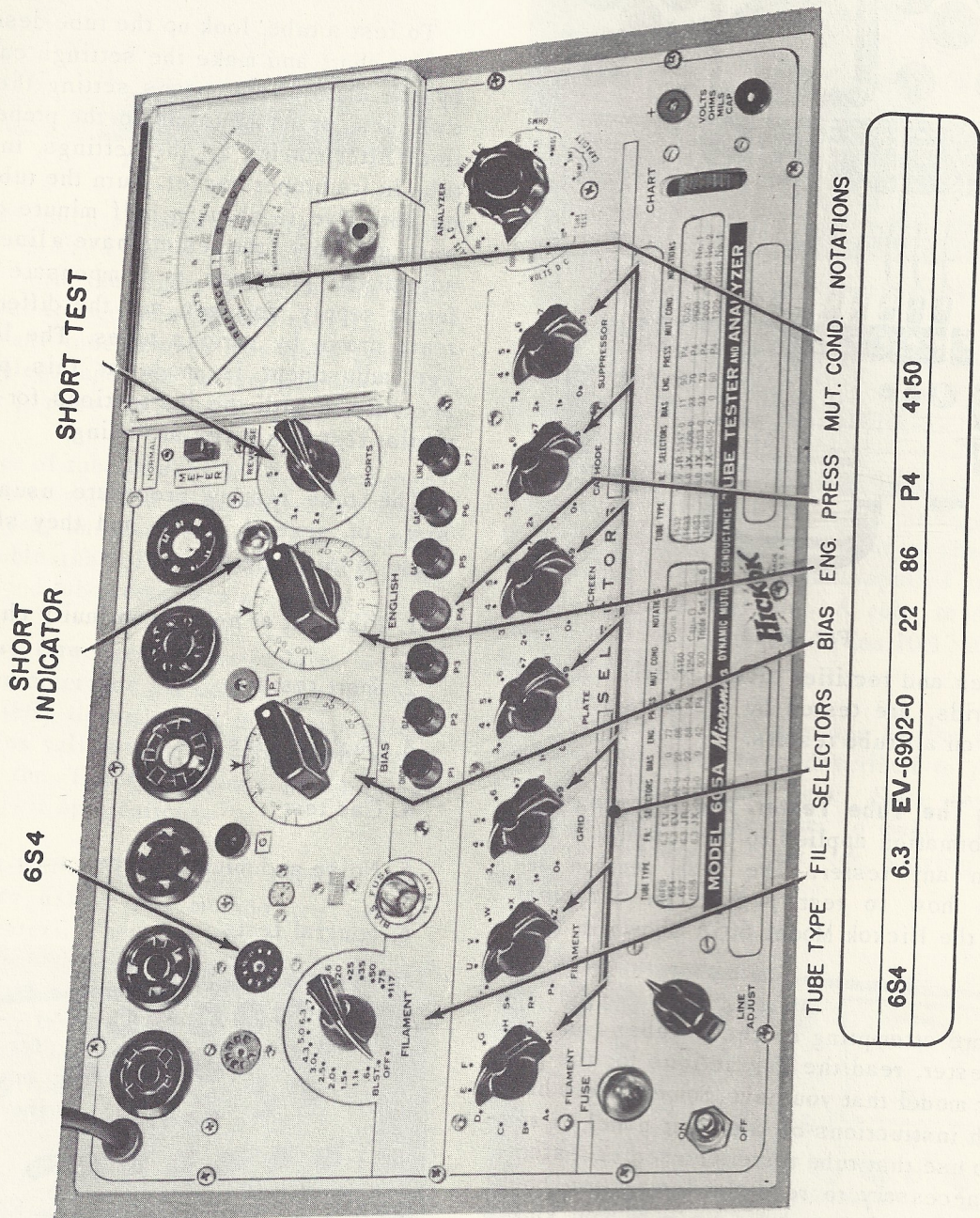


Fig. 10-13

The filament or heater continuity test shows whether the filament or heater is good. A neon bulb is used as the indicator on most tube testers; the tube-tester meter is used on others. Of course, in the case of glass tubes, it can be seen immediately whether the filament or heater is lit; in the case of metal tubes, the continuity test saves some time by immediately showing whether the filament or heater is good or bad.

The short test shows whether there are any connections between the elements of the tube. The same neon lamp that is used for the continuity tests indicates shorts. To make the short test, various levers or pushbuttons are depressed, and the neon lamp will light if there is a connection between elements. In certain tubes, there is a connection between certain elements, and there will be a note next to that tube in the tube chart that the neon lamp should glow. If there is no such note and the neon lamp glows, an undesired connection or short exists between elements. *Do not make any further tests on a shorted tube, or damage to the tube tester may result.* Only if a tube passes the short test should the remaining tests be made. The tube being tested should be tapped lightly with the eraser of a pencil while the short test is being made. Flashes in the neon lamp indicator show that intermittent shorts between the elements exist. Such a tube will probably cause noise or erratic operation in the receiver, or develop a permanent short soon.

The quality check of the tube is made by one of the three methods previously described, depending upon the tube tester being used. When the proper buttons or switches are operated, as specified in the instruction manual for the tester, the meter will indicate the condition of the tube. Depending upon the tube tester, the reading may be either on a Good-Bad scale or on a scale calibrated in micromhos. Tubes that give a reading in the Bad section of the scale should be replaced. Tubes reading in the doubtful or weak section of the scale may be used, but preferably should be replaced to avoid future trouble. If the tube tester is calibrated in micromhos, any tube giving a reading of less than 70% of the value given in the chart should be replaced.

Many tubes contain two or more sections in one envelope. Each section of such a tube must be individually tested, both for shorts and quality. The tube-tester chart will call attention to two such tubes by having two or more sets of settings for them. To test a multisection tube, make all the settings for the first section, and test the tube. Then turn the tube tester off and make the settings for the other section. After all the settings have been made, turn on the tester and make all the tests on the other section. Proceed in this way until all the sections of the tube are tested. Many tube tester manufacturers make provisions in their tube testers for estimating the useful life of a tube. This is done by reducing the filament or heater voltage by some predetermined amount, and making a quality test of the tube at this reduced filament voltage. In accordance with the instructions given, the technician may then estimate the expected life of the tube.

Using The Hickok Model 605A Tube Tester

In this section, we will describe in detail how to set up a number of typical tubes on a representative tube tester. We will show how to test a type 6S4 tube on a typical tube tester, the Hickok Model 605A tube tester, which is shown in Fig. 10-12. Most other tube testers have similar set up procedure. The procedure is as follows:

1. Turn on the tester and allow it to warm up. Do not insert the tube into its socket. Set the ANALYZER switch, which is directly below the meter, to the TUBE TEST position.
2. Turn the roller chart until the data for 6S4 type tube is visible. An enlargement of this portion of the roller chart and the engraved labels which appear on the case is shown at the bottom of Fig. 10-13.
3. The 6S4 is a miniature glass tube requiring a filament supply of 6.3 volts. This is shown by the first column of the chart, under the heading FIL. Set the FILAMENT knob of the tester to 6.3. The location of the controls corresponding to each column of the roller chart are indicated on Fig. 10-13 by arrows connecting the roller chart label to the corresponding control.

4. The next column of the roll chart is labelled SELECTORS. The selectors are the seven pointer knobs running across the center of the tube tester. Under the heading SELECTORS on the roll chart, there are the letters EV and the numbers 6902-0. These seven letters and numbers are the settings, from left to right, for the seven pointer knobs, as shown by the arrows. The first selector knob is set at E, the next at V, the third at 6, the fourth selector knob at 9, the fifth at 0, the sixth at 2, and the last at 0.

5. The next column of the roll chart is labelled BIAS. The location of the bias potentiometer is shown by the arrow from the bias column of the roll chart. For the 6S4 tube, the bias setting is 22. The bias potentiometer is set to 22. The bias potentiometer is calibrated from 0 to 100. Each small division of the bias scale is one unit.

6. The next column on the roll chart is labelled ENG., which is the abbreviation for English. The location of the English potentiometer is shown by the arrow. This potentiometer has a scale similar to that of the bias knob, where each small division on the scale is one unit. The English setting for the 6S4 tube is 86, and the English pointer is set at 86.

7. After all the settings are made, the tube is inserted in the proper socket. The 6S4 is a nine-pin miniature glass tube, and the proper socket is shown by the arrow.

8. Set the line voltage by holding down the pushbutton P7 and adjust the LINE ADJUST knob until the meter pointer is exactly over the LINE TEST mark at the center of the scale. This establishes standard voltages for testing the tube.

9. The SHORTS switch has six positions. The first five are used in testing the tube for shorts. The sixth position, TUBE TEST, is used when testing for mutual conductance. USE THE TEST POSITION ONLY IF THE TUBE HAS NO SHORTS. Turn the shorts switch through positions 1-2-3-4-5 while gently tapping the tube with a pencil eraser and watch the neon-lamp short indicator. Shorted

elements in the tube will cause the neon lamp to glow. A momentary flash of the neon lamp as the switch is turned from one position to the next should be disregarded. A shorted tube should be discarded without further test. Note the position of the switch at which the neon lamp glows. Look up these positions in the instruction book to find out which elements are shorted.

If the tube passes the shorts test, it should be tested for mutual conductance. Turn the SHORTS switch to the TUBE TEST position. Press the P4-GM push button and read the meter. The tube tester meter will indicate the quality of the tube on the ENGLISH READING, or GOOD-BAD, scale.

To obtain the mutual conductance of the tube in micromhos, the English potentiometer is *not* set according to the figure given under the English column of the roll chart, but is set to one of three red dots on the English potentiometer scale according to the mutual conductance reading expected. On the tube-tester portion of the meter scale, shown separately in Fig. 10-14, there are three ranges: a 0-3000 micromho range, a 0-6000 micromho scale, and a 0-15000 micromho scale. According to the roll chart, the average mutual conductance of a 6S4 tube is 4150 micromhos. Therefore, the second range of the meter should be selected by setting the appropriate dot on the English potentiometer alongside the pointer. When the P4-GM pushbutton is depressed, the meter will indicate the mutual conductance of the tube in micromhos. If the meter reading is less than 70% of the chart value, the tube should be replaced.

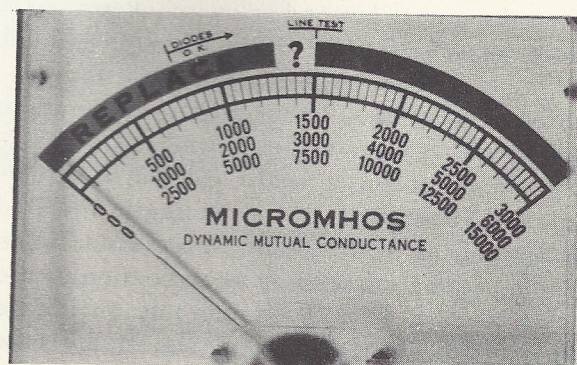


Fig. 10-14

When reading mutual conductance in micromhos, the REPLACE-GOOD scale is disregarded. An estimate of the expected life of a tube can be made, in accordance with the manufacturers instructions, in this manner:

1. Measure the mutual conductance of the tube in the usual manner.
2. Press the GM button on the tube tester and adjust the ENGLISH dial until the meter reads at 2000 on the 0-3000 micromho scale.
3. Reduce the filament voltage to 75% of the rated value (using the nearest step on the filament-voltage selector switch). If the meter still reads in the green (GOOD) section of the scale, the tube has a large life reserve. Of course, you must still use considerable judgment, taking into consideration the type of service in which the tube is being used, to decide whether tubes should be replaced on the basis of such tests.

Testing Multi-Section Tubes. Many tubes actually contain two or more tubes within one envelope. A type 6SN7 tube, for example, contains two complete and separate triodes in one envelope. Each section of such tubes must be tested separately. The portion of the tube chart showing the settings for the 6SN7 is shown in Fig. 10-15.

Note that two groups of settings are given for this tube, and that they are joined by a bracket to call to your attention that this is a two-section tube. To test this tube, the settings are made first for the one section. The shorts test, quality test, and other applicable necessary tests are made for that section. Then the settings for the other section are made, and tests are repeated. Whenever more than one group of settings is given, all these tests must be made in order to check the tube.

TUBE TYPE	FIL	SELECTORS	BIAS	ENG.	PRESS	MUT. COND.	NOTATIONS
6SN7	6.3	JX-4506-1	23	79	P4	2600	Triode No. 1
6SN7	6.3	JX-2103-5	23	79	P4	2600	Triode No. 2

Fig. 10-15

TUBE TYPE	FIL	SELECTORS	BIAS	ENG.	PRESS	MUT. COND.	NOTATIONS
5U4	5.0	HR-0600-0	0	35	P3★		Plate No. 1
5U4	5.0	HR-0400-0	0	30	P3★		Plate No. 2

Fig. 10-16

Testing Rectifier Tubes. The portion of the test chart for a 5U4 rectifier tube is shown in Fig. 10-16.

For this tube, no figure is given in the MUTUAL CONDUCTANCE column. Notice the star (★) that is next to the pushbutton number in the PRESS column. This indicates that the mutual conductance of such tubes is not measured and that the quality of such tubes can be read only on the REPLACE-GOOD scale.

Certain tubes are good even though they may give a reading in the REPLACE section of the meter scale. An example of this type is the 1X2. The settings for this tube are shown in Fig. 10-17.

In the notations column is the remark "Cap=P. OK ABOVE DIODES OK." The meaning of this note is simply that this tube is good if the meter needle falls to the right of the DIODES O.K. mark on the meter scale. A close-up view of the meter scale where this mark may be seen is shown in Fig. 10-14.

The first part of this note shows that this tube requires that a connection be made to cap on the tube, as shown in Fig. 10-18. Such caps connect to the grid or plate of the tube. In this case, the cap on the tube is connected by the special lead provided to the jack on the tube test labelled P.

Testing Electron-Ray Tubes. An electron-ray or MAGIC EYE[®] tube is a special form of tube used as a tuning indicator to indicate accurate tuning. This tube contains an elec-

TUBE TYPE	FIL	SELECTORS	BIAS	ENG.	PRESS	MUT. COND.	NOTATIONS
1X2	1.1	BS-0000-0	0	80	P5★		CAP. P. OK ABOVE DIODES OK.

Fig. 10-17

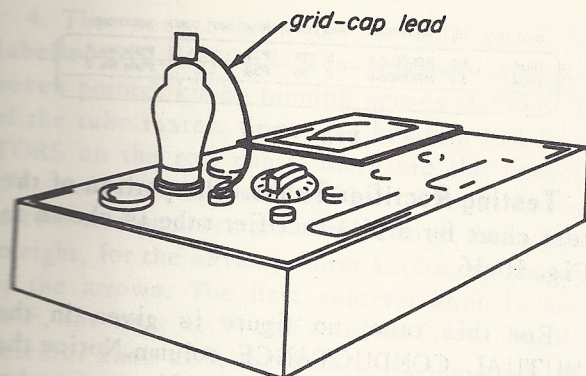


Fig. 10-18

trode coated with fluorescent material which glows when bombarded by electrons. In one popular type, a fan-shaped shadow appears on the fluorescent screen, and this shadow covers more or less of the screen as the receiver is tuned. The fan opens or closes, depending upon the tuning. Accurate tuning usually is indicated by maximum closing of the fan or eye, as it is called. The settings for the 6U5 type, which is a typical electron-ray or MAGIC EYE ® tube, are shown in Fig. 10-19.

The notations "Eye Open" and "Eye Closed" refer to the opening and closing of the fan-shaped shadow area. The eye should completely open at one setting and completely close at the other setting, as indicated in the chart.

Testing Cold-Cathode Rectifiers. Certain special tubes do not have a filament, but generate heat for the cathode in other ways. The settings for an OZ4, which is typical of this type, are shown in Fig. 10-20.

Notice first of all that this tube consists of two sections, so that two separate tests are required to completely check this tube. No filament voltage setting is given, which means that the filament knobs may be left at any point. The star after the push-button number indicates that the quality of this tube is shown on the REPLACE-GOOD scale.

TUBE TYPE	FIL	SELECTORS	BIAS	ENG	PRESS	MUT. COND	NOTATIONS
6U5	6.3	JR-5403-0		P4			Eye Open
6U5	6.3	JR-5423-0		P4			Eye Closed

Fig. 10-19

TUBE TYPE	FIL	SELECTORS	BIAS	ENG	PRESS	MUT. COND	NOTATIONS
OZ4		JR-0507-0	0	70	P2★		Plate No. 1
OZ4		JR-0307-0	0	70	P2★		Plate No. 2

Fig. 10-20

10-7. BUYING A TUBE TESTER

There are many makes and models to choose from, and many factors to consider when buying a tube tester.

One of the first things to consider is the ease of operation. Some tube checkers use push buttons, others use lever switches, while still others have rotary switches. You may find one type easier to use than others. One thing to consider is whether the roll chart is easy to read and operate.

Another thing to consider is the size of the tube checker. There are portable models, bench models, and counter models. The counter models have a very large meter so that they can easily be seen by customers. Which model is suitable for your needs? Consider also whether the scale is easy to read.

A third point to think about is the flexibility of the tester. Will it handle all present tubes and does it have provision for future tubes? Or can it be easily adapted to test new tubes as they come out? What provision has the manufacturer made to furnish you with information on new tubes? Are new roll charts supplied periodically to keep the tube tester up to date? Is the cost of these new charts reasonable?

And finally, will the instrument take a lot of use? Are replacement parts readily available? Does the manufacturer have repair facilities?

After you have obtained the answers to these questions, you will be in a good position to make your choice. In order to familiarize you with some of the tube testers sold today, photographs of several commercial service-type tube testers are shown in Fig. 10-21.

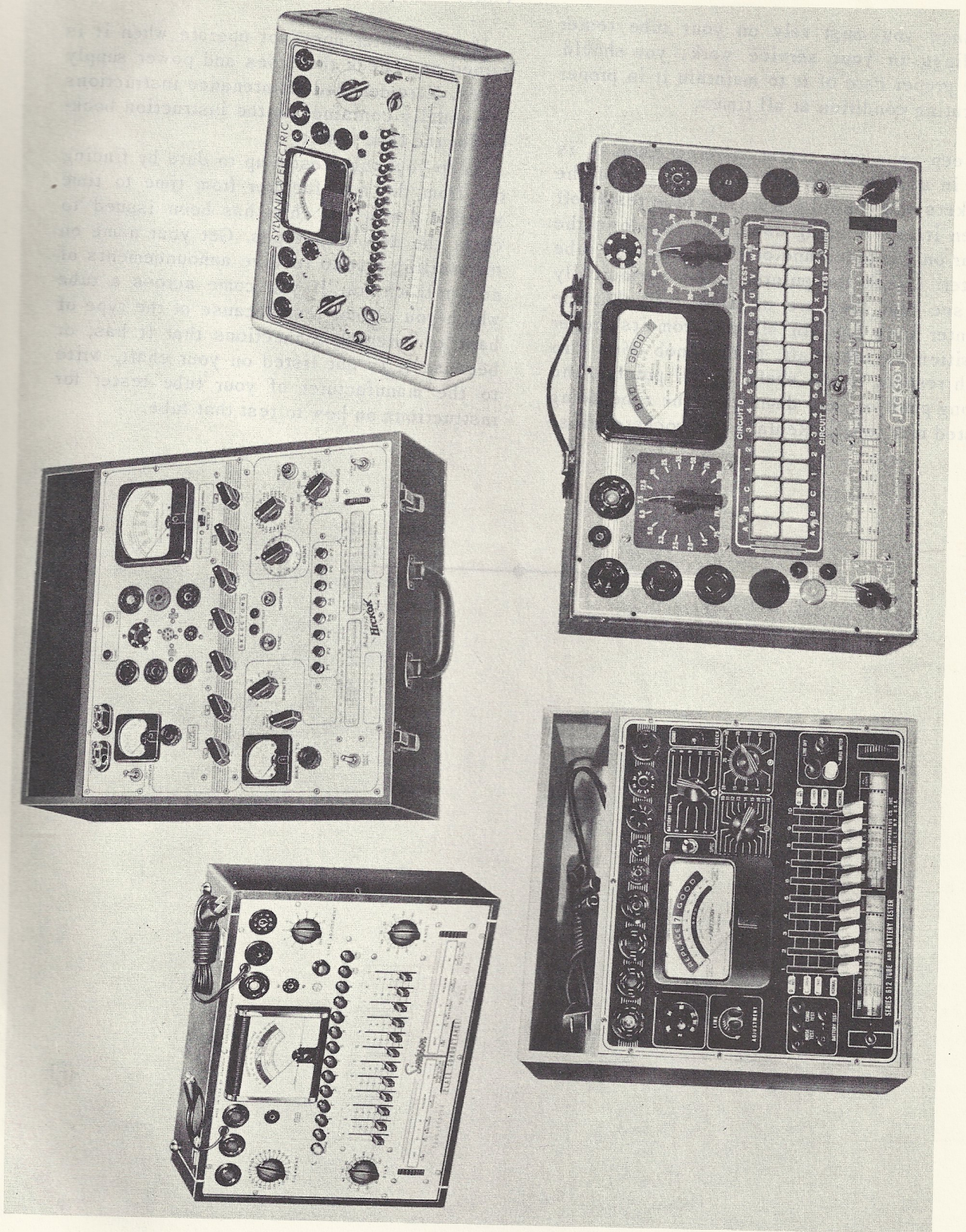


Fig. 10-21

10-8. MAINTAINING YOUR TUBE CHECKER

Since you must rely on your tube tester readings in your service work, you should take proper care of it to maintain it in proper operating condition at all times.

Keep your tube tester covered when it is not in use, to keep dust and dirt out of the sockets and controls. Turn the tube tester off when it is not being used, to keep down the wear on the tubes and other parts in the tube tester. Check the pointer knobs periodically to see that they are on tight and that the pointer knob has not slipped from its proper position on the shaft. If the knob does slip with respect to the shaft, it will point to the wrong position, and damage to the tube being tested may result. Replace any sockets whose

pin contacts loosen up; otherwise your tube tester will operate erratically.

If your tester does not operate when it is turned on, check the fuses and power supply tubes. More-detailed maintenance instructions are usually contained in the instruction booklet for the tube tester.

Keep your tube tester up to date by finding out from the manufacturer from time to time, whether a new roll chart has been issued to cover the new tube types. Get your name on the mailing list to receive announcements of new roll charts. If you come across a tube which you cannot test because of the type of base or internal connections that it has, or because it is not listed on your chart, write to the manufacturer of your tube tester for instructions on how to test that tube.

